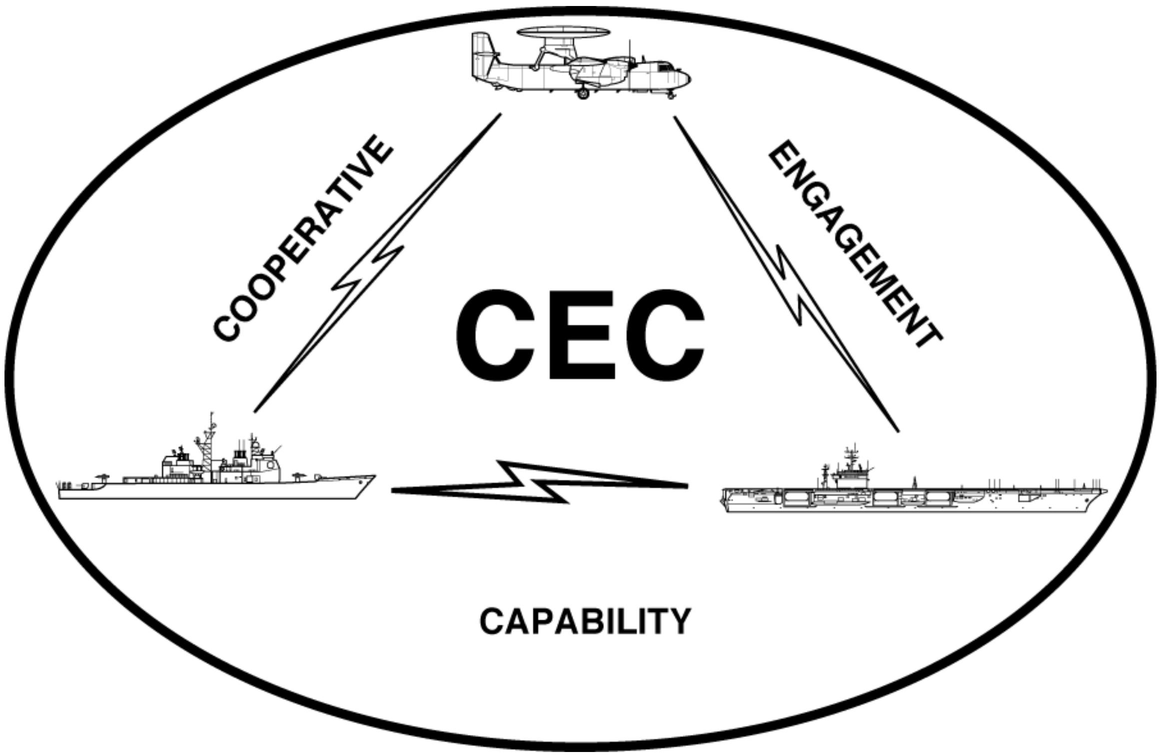
COOPERATIVE ENGAGEMENT CAPABILITY (CEC)



Navy ACAT ID Program

Total Number of Systems:	215
Total Program Cost ((TY$):	$3,576.1M
Average Unit Cost (TY$):	$77.9M
Full-rate production:	FY02

Prime Contractor

Raytheon Systems Corporation,
St Petersburg, FL

SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2020

Cooperative Engagement Capability (CEC) is a system of hardware and software that allows the sharing of radar data on air targets among ships. Radar data from individual ships of a Battle Group is transmitted to other ships in the group via a line of sight data distribution system (DDS). Each ship uses identical data processing algorithms resident in its Cooperative Engagement Processor (CEP), resulting in each ship having essentially the same display of track information on aircraft and missiles. An individual ship can launch an anti-air missile at a threat aircraft or anti-ship cruise missile within its engagement envelope, based on radar data relayed to it by another ship. Program plans include the addition of E-2C aircraft equipped with CEP and DDS to bring airborne radar coverage plus extended relay capability to CEC. CEP-equipped units, connected via the DDS network, are known as Cooperating Units (CUs).

As currently implemented, CEC is a major contributor to the ***Joint Vision 2020*** concept of ***full-dimensional protection*** for the fleet from air threats. In concert with multi-Service sensor and engagement systems, it can contribute to a major expansion of the battlespace.

BACKGROUND INFORMATION

An at-sea demonstration of CEC was conducted during FY90. An early operational assessment was conducted in FY94 based on results of at-sea developmental testing, including missile firings at the Atlantic Fleet Weapons Training Facility in Puerto Rico. Although there were significant test limitations, we concluded that CEC is potentially operationally effective and potentially operationally suitable. We also observed that this assessment must be tempered with the caveat that CEC has not undergone OT&E with the attendant operational realism. Approval to begin EMD (Milestone II) was granted in May 1995. An additional early operational assessment (OT-1A) of the airborne component of the CEC network was conducted in September 1995. In accordance with congressional guidance, the Navy certified IOC for CEC (engineering development model equipment upgraded to AN/USG-1) in late FY96.

OT&E to support the initial LRIP decision of AN/USG-2 equipment was conducted in August 1997. Although CEC was assessed as being potentially operationally effective and potentially operationally suitable, significant problems were observed in Battle Group interoperability and in software reliability. Interoperability problems experienced in early 1998 at-sea testing with the latest Aegis Weapon System software involved CEC, as well as the Aegis Weapon System, ACDS Block 1, and the command and control processor for the tactical data links. Deficiencies were in the areas of track management, net operations, cooperative engagement, engagement support, composite identification, and link interoperability. This resulted in freezing the CEC software configuration (Baseline 2) and decelerating CEC development so that associated system software (Aegis Weapon System (AWS) Baseline 6.1 and Advanced Combat Direction System (ACDS) Block 1) could reach maturity. An important lesson from this was that CEC is but one element of a larger system of systems, with the proper integration of elements essential for operationally effective and suitable operation. As a result, the PEO implemented an analytical and management structure to examine test data from the major sub-systems: AWS, ACDS Block 1, CEC, and the tactical data link command and control processor. Through collaborative analysis between the major sub-system teams, rapid feedback was provided to a senior system engineering council that made recommendations to the PEO regarding software modifications to enhance overall system performance. In addition, the Naval Sea Systems Command initiated the definition of battle force level interoperability requirements.

The re-planned program, challenged by the requirement to synchronize testing with fleet deployment schedules, included four at-sea test periods in 2000, followed by TECHEVAL and OPEVAL in 2001. The full production decision is expected during 1QFY02.

TEST & EVALUATION ACTIVITY

An OA of CEC (AN/USG-3 equipment) installed in an E-2C aircraft was conducted in October 1999. The two periods of testing included operations first with the two land-based test sites at Wallops Island and Dam Neck, VA, followed by CEC network operations with an Aegis Baseline 5.C cruiser. A P-3 aircraft, modified to emulate an E-2C, participated in both periods. The AN/USG-3 allowed integration of the E-2C surveillance radar and Identification Friend or Foe (IFF) sensor into CEC networks. The OA was conducted in accordance with a DOT&E-approved test plan and TEMP.

The first underway period to examine software modifications to CEC, Aegis Baseline 6.1, ACDS Block 1, and C2P as a result of the 1999 test-analyze-fix iteration, was in February 2000 in the Virginia

Capes area. These were engineering tests. Participants included an Aegis Baseline 6.1 cruiser, a CEC-equipped P-3 aircraft, the land-based test site at the Ship Combat Systems Center, Wallops Island, VA, the land-based test site at Dam Neck, VA, and the relay tower at Eastville, VA. Tracking runs were conducted with aircraft and target drones. EA against radars was used during several tracking tests. Tests were conducted with CEC, both on and off, for comparison. During this underway period and each of the following, a non-CEC Aegis destroyer participated to examine CEC effects on the tactical data link of the non-CEC participant. In December, two non-CEC Aegis destroyers participated.

Developmental testing (DT-IIE) was conducted in May 2000 at the Atlantic Fleet Weapons Training Facility in Puerto Rico. Participants included two Aegis Baseline 6.1 cruisers and aircraft carrier with ACDS Block 1 and two CEC-equipped aircraft, and a relay station at Crown Mountain, St. Thomas, Virgin Islands. Tracking runs were conducted with aircraft and target drones. Tests were conducted with CEC, both on and off, for comparison. EA was conducted against both shipboard radars and the DDS network. Six Standard Missiles and one Sea Sparrow missile were fired at target drones representing anti-ship cruise missiles. Testing was observed by DOT&E staff.

DT-IIF/OT-IIA3 was conducted in late September 2000 in the Virginia Capes operating area with two Aegis Baseline 6.1 cruisers, two Aegis Baseline 5.C cruisers, USS WASP (ACDS Block 1), and USS EISENHOWER (ACDS Block 1) from pierside in Norfolk, VA. The two land-based test sites (Wallops Island and Dam Neck), connected by the Eastville, VA relay tower, were participants, as were two CEC-equipped aircraft (E-2C and a P-3 that was equipped with an E-2C surveillance radar). Tracking runs were conducted with aircraft. EA was conducted against ship radars. OT was conducted in accordance with a DOT&E-approved test plan and TEMP, although a combination of target drone control problems, interference by boats, and bad weather effects resulted in none of the planned missile firings being conducted. Testing was observed by DOT&E staff.

DT-IIG was conducted in December 2000, both at the Atlantic Fleet Weapons Training Facility in Puerto Rico and in the Virginia Capes operating area. Participants in the Puerto Rico phase included the four cruisers that were in the previous DT/OT, one CEC-equipped aircraft equipped with CEC, and a CEC node at St. Thomas. In the Virginia Capes area participants were the four cruisers, the two land-based test sites, two CEC-equipped aircraft, and two ACDS Block 1 ships: USS KENNEDY and USS WASP. Extensive tracking runs were conducted against aircraft and target drones. EA was conducted against ship radars. Standard Missiles and Sea Sparrows were fired at target drones. Two non-CEC Aegis destroyers participated in the exercise. Testing was observed by DOT&E staff.

TEST & EVALUATION ASSESSMENT

The February 2000 engineering test was the first opportunity to examine the full functionality of the software planned to support the OPEVAL. The test demonstrated the overall soundness of the software changes that had been made, and revealed several additional changes required to meet the original performance goals. Comparisons between combat system performance without CEC (DDS not transmitting), and performance with CEC, indicated improvement in the overall tactical picture when CEC was contributing. Although Link 16 (TADIL J) interoperability remains a significant challenge (consistent with current fleet operational experience), the test showed CEC contribution to improving Link 16 accuracy and improved Link track number stability. Incorrect IFF association to radar tracks was also reduced, leading to improved ID accuracy.

The May 2000 developmental testing (DT-IIE), conducted in Puerto Rico, included operationally realistic scenarios along with others that focused on verification that computer program changes operated correctly. Analysis indicated that operational issues were also improving and thresholded requirements were successfully demonstrated. The intended testing of force interoperability peformance was incomplete because of some data collection failures and a ship navigation data failure, but the partial results indicated that CEC improved overall force tracking correctness.

The September 2000 combined developmental and operational testing (DT-IIF/OT-IIA3), conducted in the Virginia Capes operating area, brought to the CEC net both the largest number of cooperating units yet tested and the largest number of air tracks encountered during testing. Tracking runs were conducted with aircraft and EA was conducted against ship radars, but a combination of target drone control problems, interference by boats, and bad weather effects resulted in none of the planned missile firings being conducted. Notwithstanding the lack of missile firings, much was learned in the areas of network stability, track identification, CEC tracking, and display system limitations. Software fixes were put in place to correct deficiencies observed during the September testing, in preparation for the next testing in December.

The December 2000 developmental testing (DT-IIG) was conducted in two phases. The first phase was with four Aegis cruisers conducting tracking exercises and Standard Missile firing exercises at the Atlantic Fleet Weapons Training Facility sea range at Roosevelt Roads, Puerto Rico. A P-3 aircraft, modified to emulate an E-2C Hawkeye airborne early warning aircraft, participated in the CEC network as did a land-based site located on St. Thomas. Both actual and simulated missile firings were conducted against targets that simulated high-altitude as well as sea-skimming enemy anti-ship cruise missiles. For the second phase, the four cruisers joined an aircraft carrier and an amphibious warfare ship on the way to the Virginia Capes operating area to conduct testing with a larger CEC network and in an area of greater air track density. Participants in the second phase also included two airborne early warning aircraft and two land-based test sites located at Wallops Island and Dam Neck. A problem observed during both DT-IIG and the preceding DT-IIF/OT-IIA3 was the proliferation of incorrectly identified air tracks (identified as friendly). Intensive examination of the data is underway, as analysts seek to understand and isolate root causes of this and other performance-detracting problems observed during at-sea testing, and recommend modifications to improve performance during TECHEVAL and OPEVAL. Ship crews received valuable training in preparation not only for the technical and operational evaluations, but also for the ensuing deployment of the battle group.

CONCLUSIONS

The several underway periods were key to preparing the overall system for OPEVAL in FY01. The system was subjected to a regimen of testing with increasing complexity as the year progressed. Each underway testing period was followed by a focused period of analysis, determination of whether further software modifications were required, and rapid implementation of those that were required prior to the next underway period. Testing to date has indicated improvement in interoperability and overall performance of CEC, but the realism attained during the early testing and the duration of the more operationally realistic testing have not been sufficient to conclude with high confidence that most operational problems have been identified.

Synchronization of OPEVAL with fleet deployment schedules remains a challenge. This is due in part to the requirement to have an adequate number of ship CUs. From an OT&E perspective, ensuring that enough CUs participate in the CEC net during end-to-end (detection through intercept of targets representing anti-ship cruise missiles) testing is critical to achieving a realistic environment for operational evaluation of this complex system prior to its delivery to fleet operators. This is a test adequacy issue that is among the key drivers for the OPEVAL.

This "system of systems" using different ship classes and aircraft is replete with interoperability challenges as well as the potential for significant progress toward realization of a single integrated air picture for Battle Group units. The interoperability challenges are the major obstacles, and the Navy is addressing them impressively, as evidenced by their significant commitment of ships, aircraft, land-based test sites and other resources during multiple at-sea periods of testing. The collaborative assessment process and the system of rapid feedback, based on testing results regarding software design changes, are working. Additionally, the Navy has implemented an effort to develop appropriate fleet tactics, techniques, and procedures to mitigate persistent deficiencies in the CEC-equipped battle groups and maximize the effectiveness of the new capabilities. Indeed, this PEO's overall approach could establish a pattern for emulation by other acquisition managers challenged with the development and delivery of complex, highly interactive "systems of systems" that cut across PMs, PEOs, Systems Commands, and other organizational boundaries.